Forage Fish Beach Spawning Monitoring in the Aquatic Reserves

2016-2018 Monitoring Report

Grant #: 15-05467: Puget Sound Marine and Nearshore Protection and Restoration - Citizen Science and Stewardship of the Aquatic Reserves in the Salish Sea

Prepared for:

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee

Maury Island Aquatic Reserve Citizen Stewardship Committee

Nisqually Reach Aquatic Reserve Citizen Stewardship Committee

Prepared by:

Erica Bleke, Betty Bookheim, Caleb Dobey, Jamie Kilgo
DNR Aquatic Reserves Program

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This monitoring report describes the ongoing research and monitoring of forage fish beach spawning surveys conducted in 2016-2018 in three Washington State Department of Natural Resources aquatic reserves: Fidalgo Bay Aquatic Reserve, Maury Island Aquatic Reserve, and Nisqually Reach Aquatic Reserve. This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement PC-00J90701 through the Washington Department of Fish and Wildlife. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the Washington Department of Fish and Wildlife, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Copies of this Report will be available from the Washington State Department of Natural Resources at https://www.dnr.wa.gov/managed-lands/aquatic-reserves and http://www.aquaticreserves.org/resources/

Cover photo: Experienced volunteers train a new volunteer at Fidalgo Bay Aquatic Reserve, Erica Bleke

Author and Contact Information

Erica Bleke
Washington Department of Natural Resources
erica.bleke@dnr.wa.gov

Betty Bookheim
Washington Department of Natural Resources
betty.bookheim@dnr.wa.gov

Caleb Dobey
Washington Department of Natural Resources
caleb.dobey@dnr.wa.gov

Jamie Kilgo
Washington Department of Natural Resources
jamie.kilgo@dnr.wa.gov

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Abstract

The Washington Department of Natural Resources is steward of 2.6 million acres of state-owned aquatic lands. The Aquatic Reserves Program has established eight aquatic reserves throughout Washington State to protect important native ecosystems within these state-owned aquatic lands. Many reserves are supported by Citizen Stewardship Committees that plan and conduct education, outreach, and citizen science within the reserve in their community.

Trained citizen scientists conduct forage fish beach spawning surveys in three of Department of Natural Resources Aquatic Reserves: Fidalgo Bay Aquatic Reserve, Maury Island Aquatic Reserve, and Nisqually Reach Aquatic Reserve. Each of these reserves have goals and objectives in their management plans that outline the importance of identifying forage fish spawning locations and taking measures to preserve or restore those areas. As a vital link in the Salish Sea's food web, forage fish are an important part of supporting recovery of the Salish Sea. Monitoring is essential to determine if, how, and when forage fish are using beaches in the reserves. The natural and/or human-induced potential impacts on reserve beaches cannot be tracked without such data. Moreover, environmental and policy related questions posed by governmental agencies or interested groups can be addressed more effectively with current, vetted, and accessible data.

Each group of volunteers conducts forage fish beach spawning surveys using established Washington Department of Fish and Wildlife protocols. The number and timing of when samples are collected and processed and the level of lab work that each volunteer group is able to assist with varies due to the needs of the reserve and the capacity of the volunteer groups. The Puget SoundCorps assists all groups with some sampling or lab work including identification and quantification, QA/QC and data entry of all collected samples. The Department of Natural Resources enters this data in the Aquatic Reserves Data Viewer, and then sends it to Washington Department of Fish and Wildlife, for inclusion in the statewide Forage Fish Spawning Location Map.

Introduction

Project Background

The Department of Natural Resources (DNR) Aquatic Reserves Program (ARP) has established eight aquatic reserves throughout the state to protect important native ecosystems on state-owned aquatic lands. Through its aquatic reserves, DNR promotes the preservation, restoration, and enhancement of state-owned aquatic lands that are of special educational, scientific, or environmental interest. One benefit of the ARP is the partnerships DNR establishes to aid in development and implementation of aquatic reserve management plans. DNR works with federal, state, local, tribal and non-governmental organizations and private citizens in an effort to identify and manage important resources for conservation at each reserve. This report summarizes results of forage fish monitoring done by three citizen science groups in three aquatic reserves: Fidalgo Bay Aquatic Reserve (FBAR), Maury Island Aquatic Reserve (MIAR), and Nisqually Reach Aquatic Reserve (NRAR).

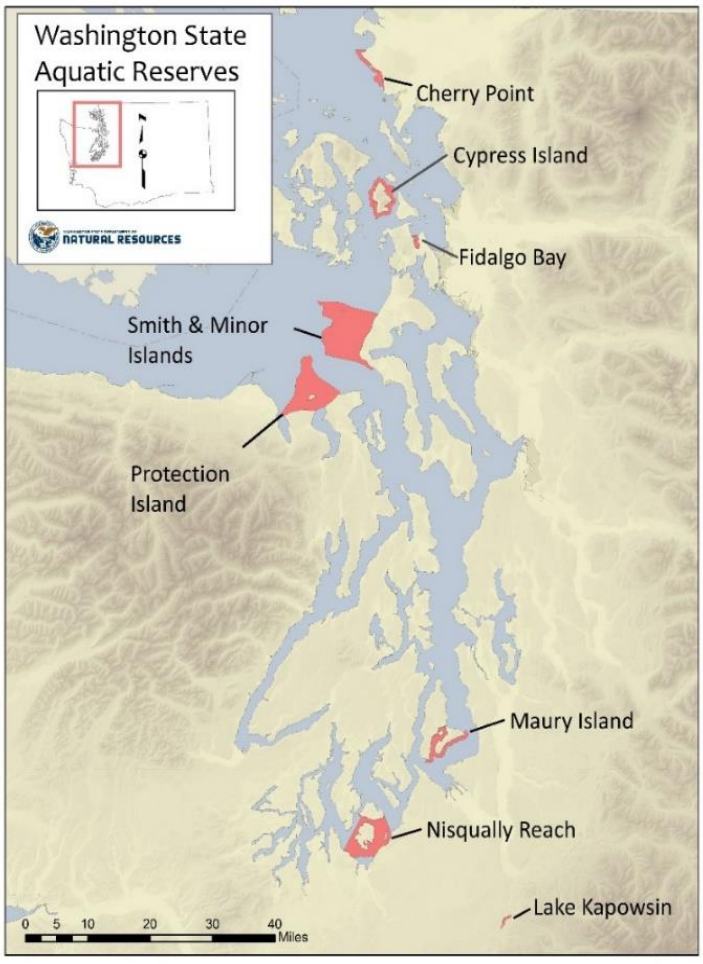

Figure 1: DNR Aquatic Reserves including Fidalgo Bay, Maury Island, and Nisqually Reach Aquatic Reserves

Each of these reserves has its own citizen stewardship committee (CSC) and associated local organizations that act as fiscal sponsors and provide staff support to the CSC. Table 1 shows the partners involved in this project. These partners are responsible for all aspects of intertidal forage fish spawning monitoring including: recruitment of volunteers, training coordinated in association with DNR, provision of equipment, coordination and supervision of sample collection, review of completed data forms, cataloging and safeguarding of collected materials, and coordination of the processing of the samples through DNR in association with Washington Department of Fish and Wildlife (WDFW). Results from the laboratory analyses are made available to the partner organizations for inclusion in their reports. Table 2 lists the key individuals and their responsibilities in this project.

Reserve	**Local organization(s)**
Fidalgo Bay	FBAR CSC; RE Sources for Sustainable Communities; Puget Sound Corps (PSC)
Nisqually Reach	NRAR CSC, Nisqually Reach Nature Center (NRNC); PSC
Maury Island	PSC, Vashon Nature Center, Vashon Land Trust

Table 1: Lead Organizations for Organizing Activities in Each Reserve

Individual	**Responsibilities**
Caleb Dobey (DNR)	Coordinate activities between PSC and AR CSCs
Pete Haase	Coordinate collection in FBAR
Terence Lee	Coordinate collection in NRAR
Bianca Perla	Coordinate collection in MIAR

Table 2: Key Individuals and Their Responsibilities

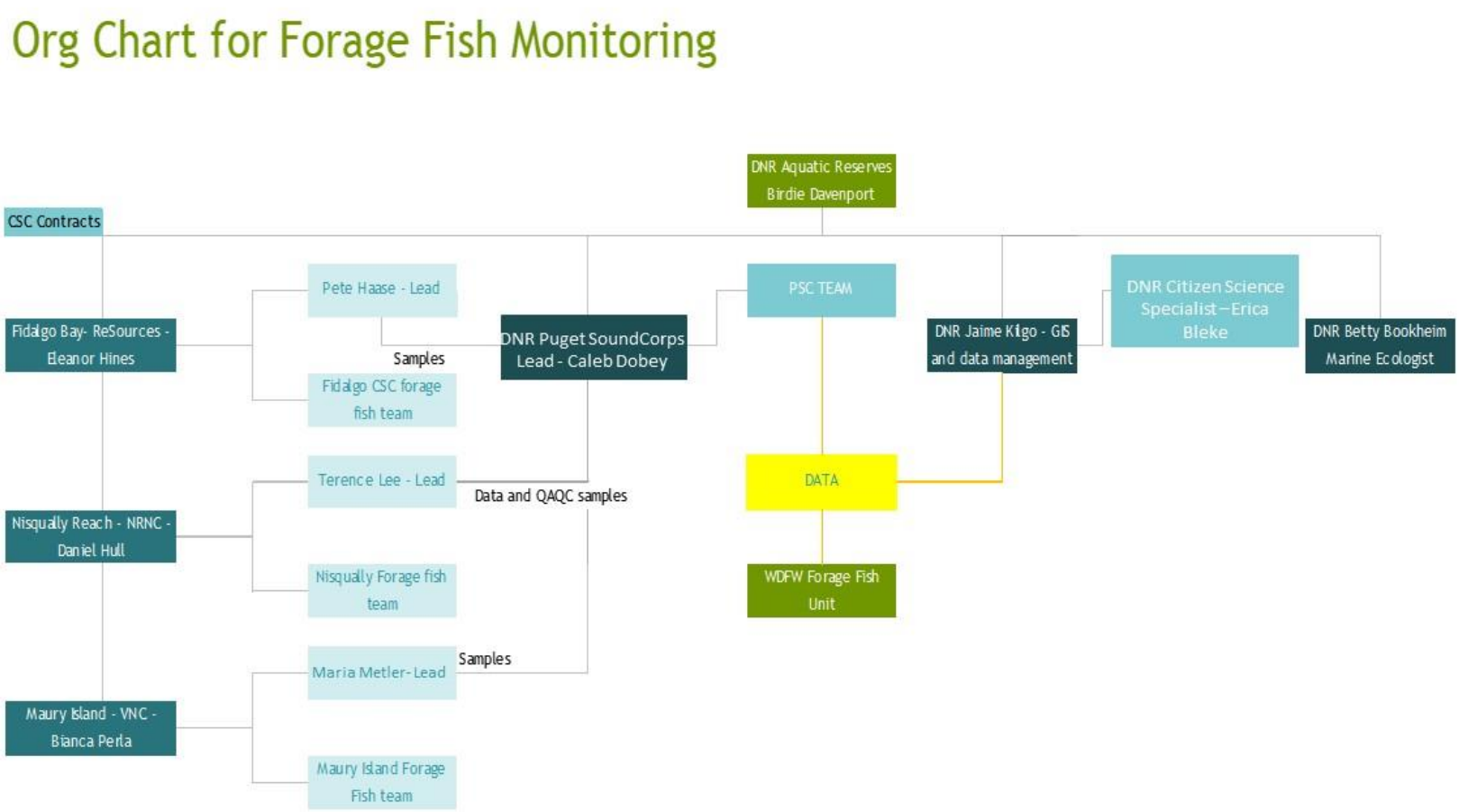

Figure 2: Organizational Chart for Forage Fish Monitoring Workflow

Each partner organization coordinates training events with the DNR Aquatic Reserves Program. In some cases, the PSC Team is available for additional training for those citizen science volunteers wishing to expand their knowledge and understanding of the monitoring protocol. Online resources from WDFW are also available, and all citizen-science volunteers are directed to these resources. These include forage fish beach survey training materials and established protocols, available at http://wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/ (accessed November 15, 2018). DNR assists in the standardization of protocols across the reserves as well as communications and coordination with local and state agencies.

Reserve Backgrounds

FBAR was established in 2008 and is located east of Anacortes, in northwestern Skagit County. FBAR contains diverse physical habitats that include tidal flats, fringing salt marshes, sand and gravel beaches, and expansive native eelgrass beds. These habitats are recognized as essential contributors to the reproductive, foraging, and rearing success of many fish and bird species.

Three species of forage fish—Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiousus*), and Pacific sand lance (*Ammodytes personatus*) use intertidal and shallow subtidal areas in Fidalgo Bay for spawning habitat and constitute a major portion of the diets of salmon, seabirds, marine mammals, and other fish.

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (FBAR CSC) has dedicated volunteers that have been collecting and processing beach spawning forage fish samples weekly since 2012. In 2017, FBAR CSC purchased a dissecting scope and participated in an initial training provided by DNR that will allow them to increase their ability to assist in forage fish lab work. This work includes identification and counting of forage fish eggs and identification of the developmental stages of those eggs.

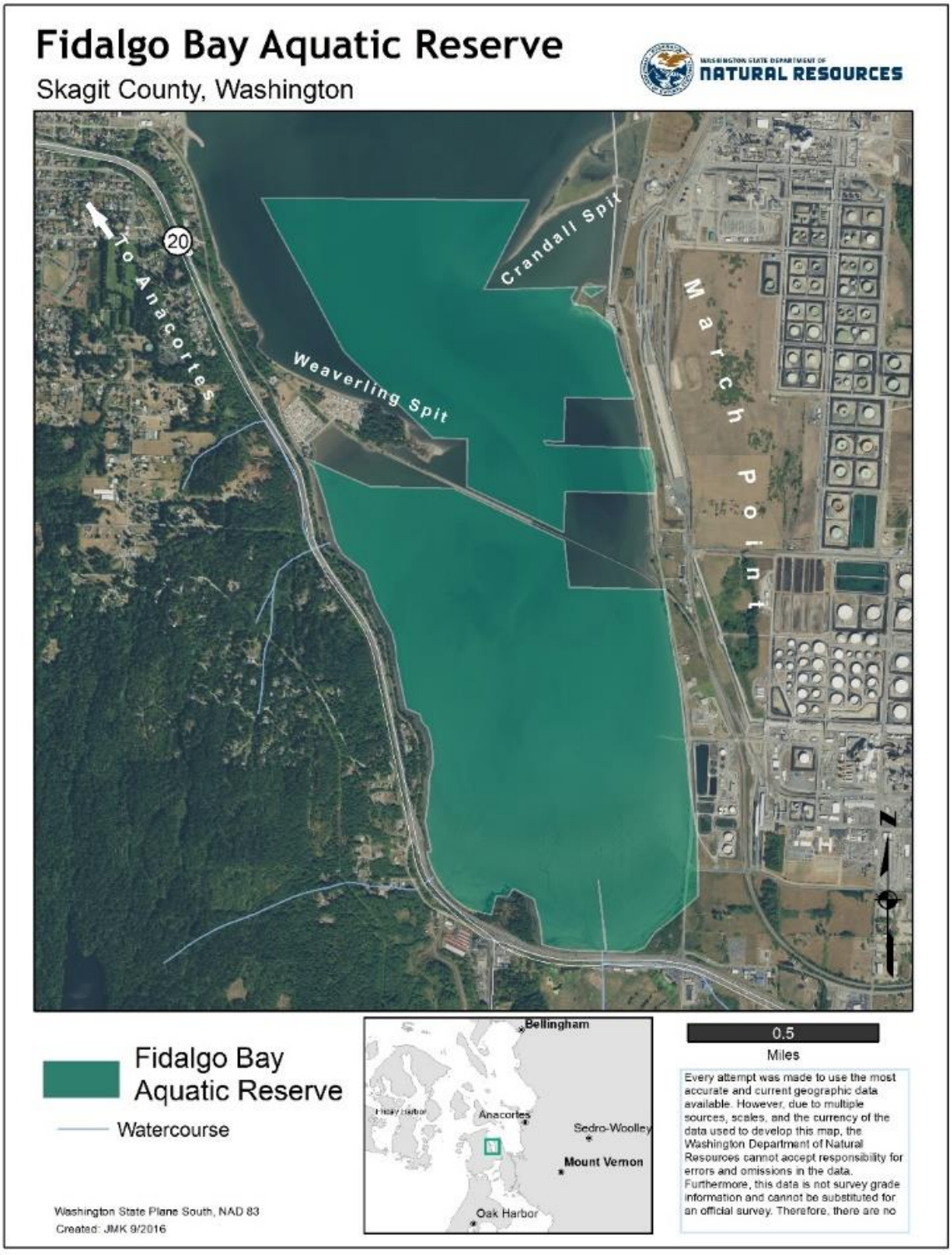

Figure 3: Fidalgo Bay Aquatic Reserve

MIAR was established in 2004 and is a highly diverse, productive, and unique ecosystem encompassing all of Vashon Island's Quartermaster Harbor in King County. The reserve's boundary also stretches outside of the harbor from Neill Point to Pt. Robinson.

The three species of forage fish that spawn in FBAR also spawn in MIAR's nearshore waters: Pacific sand lance, Pacific herring, and surf smelt. These forage fish, along with many other fishes and invertebrates that use the waters of the reserve, provide vital links in the reserve's food chain by becoming food for local bird, fish, and mammal populations.

Maury Island Aquatic Reserve Citizen Stewardship Committee (MIAR CSC) volunteers have been collecting and processing forage fish samples since 2016. That same year, volunteers began integrating forage fish data into a study they designed to understand how bulkhead removal planned for three areas within MIAR would impact the whole shoreline ecosystem. Volunteers collected three consecutive years of data prior to bulkhead removal in the summer of 2018. Sampling will continue in 2019 to provide post-bulkhead removal data.

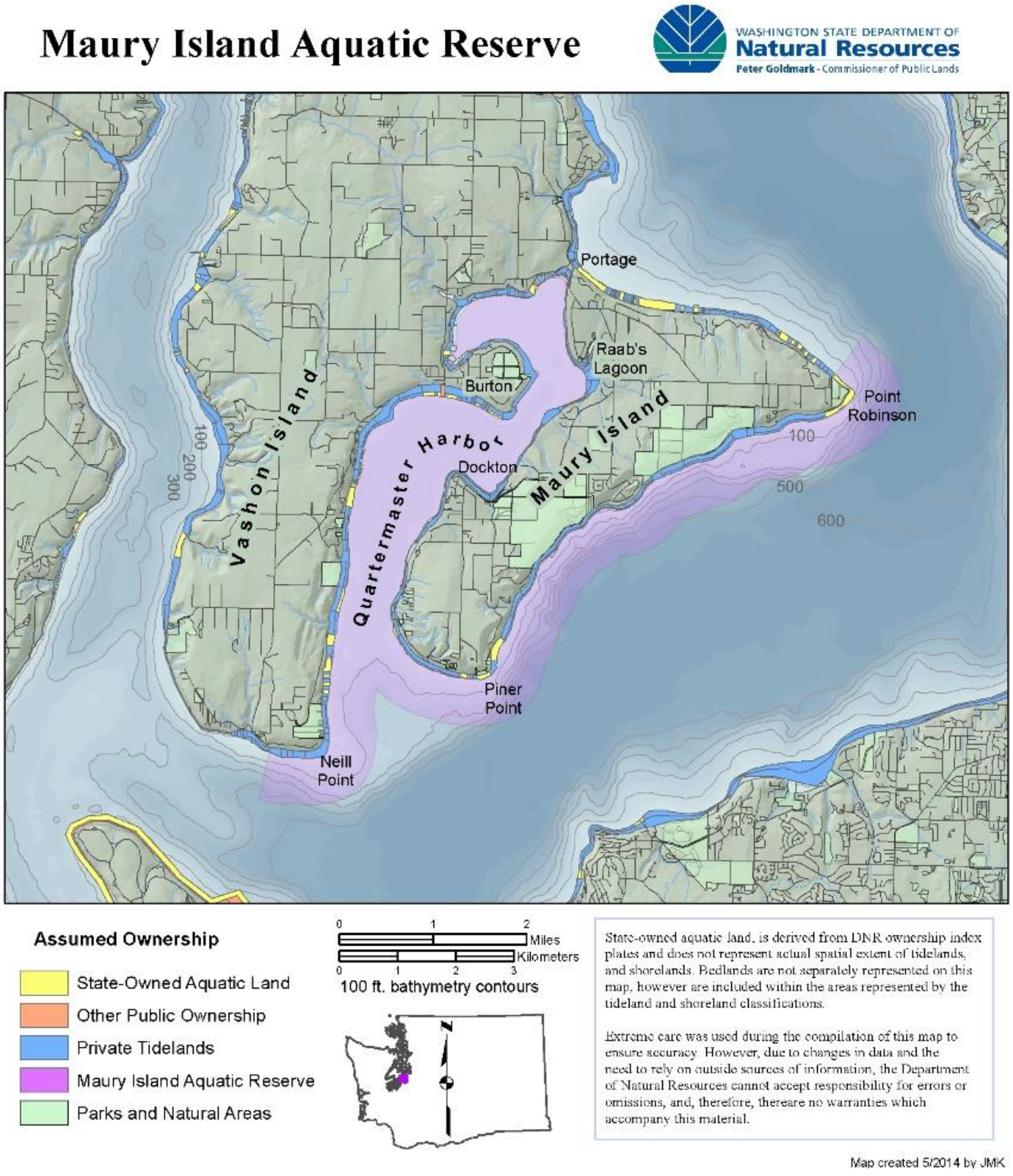

Figure 4: Maury Island Aquatic Reserve

NRAR was established in 2011. The boundary of the reserve touches the southwestern shoreline of McNeil Island, surrounds Anderson and Ketron Islands, and runs along the southern shoreline of Puget Sound from Tolmie State Park to the town of Steilacoom. The reserve is adjacent to the Billy Frank Jr. Nisqually National Wildlife Refuge and has waters in Pierce and Thurston Counties.

NRAR is an estuarine area that exhibits a wide-range of unique physical features, processes, habitats and associated biodiversity. Zones of documented upper intertidal surf smelt and sand lance spawning beaches are common along the Nisqually Reach and on Anderson Island. Pacific herring also utilize the open waters in the western portion of the reserve as their prespawner holding area, but are not known to spawn within the reserve.

Nisqually Reach Aquatic Reserve Citizen Stewardship Committee volunteers have been collecting, processing, and providing lab work analysis of forage fish samples since 2013. The group started honing in on what sites and beach elevations to collect samples from in 2016. After targeting samples to areas where they found more shell fragments, they focused sampling the beach face area within three feet below the last high tide mark. Sites were dropped due to lack of spawning or added as index sites if determined to be a more consistent spawning area.

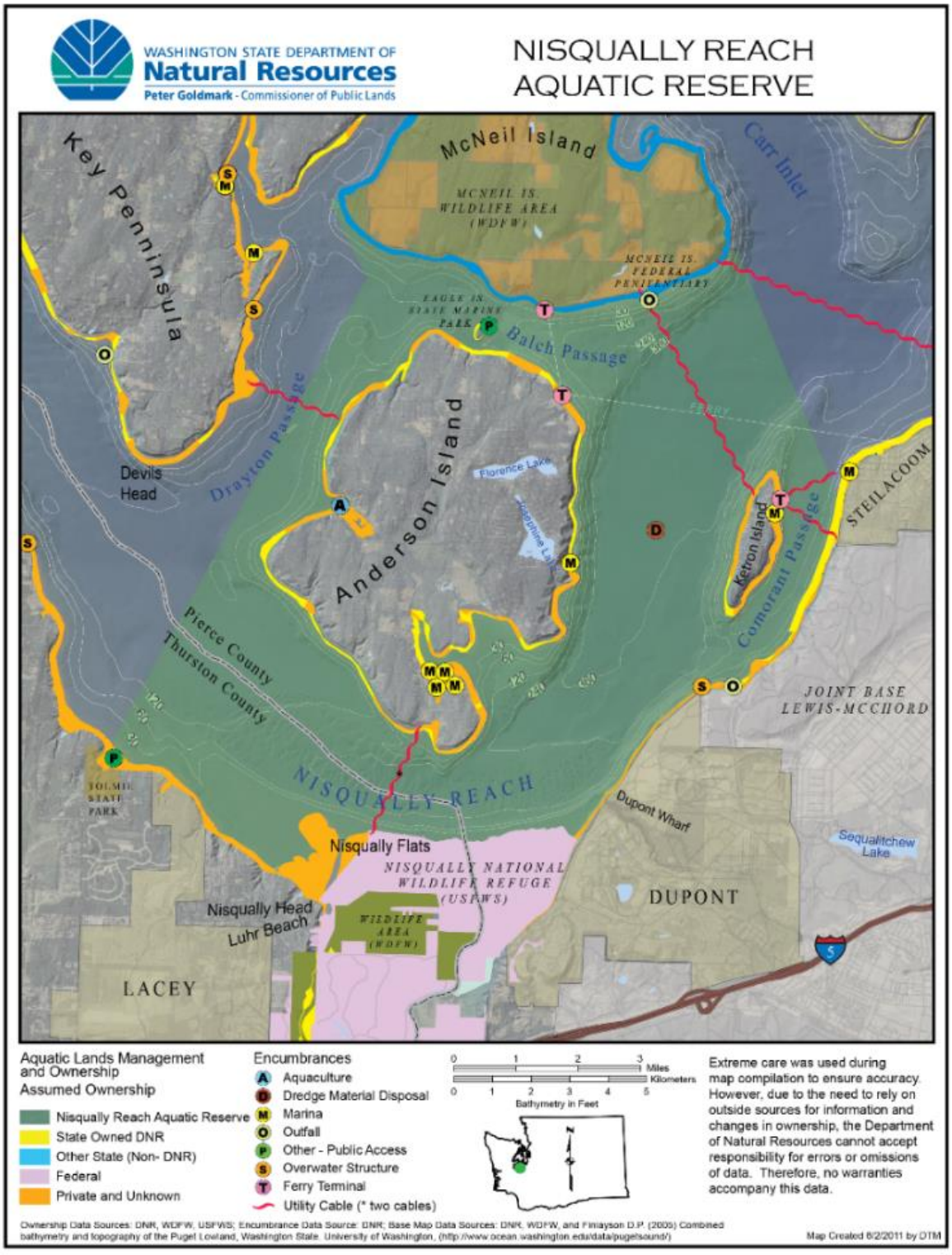

Figure 5: Nisqually Reach Aquatic Reserve

Goals and Objectives

Project goals of the intertidal forage fish beach spawning habitat surveys in aquatic reserves are to:

- Document spatiotemporal forage fish beach spawning habitat within the aquatic reserves.
- Collect baseline data and document changes over time in forage fish usage of the beaches using established methods that will provide data comparable across reserves and monitoring years.
- Effectively engage local communities in learning about forage fish ecology and their importance in Puget Sound through participation in citizen monitoring.
- Contribute to and improve the WDFW spatial and temporal distribution data for surf smelt and Pacific sand lance.

The objectives of this project are to:

- Train and empower citizen scientists in conducting surveys using a standardized protocol.
- Implement the surveys on a regular and consistent basis that can contribute to the time series from previous monitoring studies conducted in these reserves and concurrent monitoring studies in other ARs and other regions of the Salish Sea.
- Create a sustainable, locally operated structure in each reserve to continue this work after the end of this grant.

Information on the current status of forage fish populations is scarce, due to largely undetermined life histories. Because movement and behavior is not well understood, it difficult to access spawning habitat trends. As a result, it is unknown whether Salish Sea surf smelt and Pacific sand lance return to specific natal bays or areas with beaches providing more favorable habitat conditions.

Forage fish beach spawning surveys were established in the 1970s and have been recognized as a reliable way of monitoring forage fish spawning presence and determining critical spawning habitat sites (Moulton and Penttila, 2001). By using WDFW protocols, each of these citizen science groups is not only able to provide the data needed to answer their own questions, but they are providing current, vetted, and accessible data to interested local and state agencies, tribes, and non-profit organizations. The DNR enters the data collected by these citizen scientists in the Aquatic Reserves Data Viewer, which informs the public as well as the management of the reserves. The DNR then sends the data on to the WDFW, who include it in their statewide forage fish spawning habitat database and online map application.

Methods

Sampling Design and Procedures

The data collection and protocol follows the WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols, Procedures for Obtaining Bulk Beach Substrate Samples (Moulton and Penttila, 2001). Slight modifications of the protocol were made in steps 8 to winnow even further using the vortex method after sieving (Dionne, 2015). The protocol is shown in Appendix C. Once the samples are collected, sieved, winnowed, labeled, and preserved, they are transferred to DNR staff for analysis. FBAR and NRAR have index sampling sites set up in cooperation with WDFW, while MIAR sites are associated with restoration projects. Index sites are fixed locations that are surveyed monthly with the purpose of gathering baseline data on presence/absence of forage fish spawning. Surveys are conducted weekly at FBAR, and monthly at both NRAR and MIAR.

Training Description

In FBAR, the original group of citizen scientists was trained during the summer of 2012 by Dan Penttila, previously of WDFW and an expert on forage fish. There was a classroom training consisting of two hours about forage fish in general. Then there were two four-hour field trips in Fidalgo Bay on how to locate sites, collect samples, use GPS units, and fill out the various sections of the field sheet. After collecting samples, the volunteers practiced the sieving, winnowing, and preserving processes. Dan Penttila reviewed the activities and made suggestions throughout the training. The guided field trips were followed with four full surveys to practice the techniques. The Skagit Marine Resources Committee funded the training and a set of high-quality sieves.

Several additional volunteers have joined FBAR's survey group since the beginning of the program. Many have become qualified surveyors by participating in multiple trips and practicing all the various steps overseen by experienced volunteers. In 2017, citizen scientists in FBAR also took part in a training provided by the DNR that focused on forage fish lab work using dissecting scopes. Egg identification, counting, and staging were all covered. FBAR CSC has since purchased a dissecting scope and continues to practice these skills. In the future, more training will be provided by the DNR in order to help dedicated citizen scientists hone these skills.

In MIAR, two Vashon Nature Center staff were trained by WDFW in the use of forage fish protocols on October 12, 2016 at one of their regular training sessions and were certified to conduct forage fish surveys. Vashon Nature Center staff then recruited volunteers and VNC staff together with the Aquatic Reserve Program's Puget SoundCorps (PSC) team train volunteers annually in hands-on in-field trainings on forage fish sampling. These training sessions happened November 28th, 2016, June 15th, 2017, and October 5th, 2018. After in field trainings, at least one Vashon Nature Center staff member accompanies all volunteers in the field for each survey. New volunteers are always placed in groups with experienced volunteers.

The NRAR staff benefit from training held each fall in Olympia for new WDFW and DNR PSC crews that assist with forage fish surveys throughout Washington State. WDFW's Phillip Dionne leads the training, with former WDFW biologist, Dan Penttila, sometimes presenting as a guest trainer. The training is comprised of classroom, field, and lab sessions. There are one or two lecture sessions to introduce trainees to basic forage fish biology, history of forage fish research, current survey methodology, and the importance of the research. Field trainings are conducted at Geoduck Beach, near Evergreen State College, to establish familiarity with survey protocol as well as the procedure for data and sample collection. Lab training consists of two parts: sample processing, which involves hands-on practice using sieves and the vortex method, and lab analysis, which involves discussion of lab safety, proper sample preservation and storage, viewing of demo eggs for a variety of fish eggs, and practicing looking through samples for eggs. Terence Lee, the scientific technician for Nisqually Reach Nature Center, attends this training every year and is present for all forage fish sampling and lab work conducted in NRAR.

Survey Site Locations

The forage fish survey habitat spawning sites surveyed by FBAR CSC volunteers are index sites set up by WDFW. Volunteers divide Fidalgo Bay sampling locations into the west side (Northwest, Weaverling Spit, Southwest) and east side (March Point – North, March Point – South) and each side of the bay is sampled twice a month.

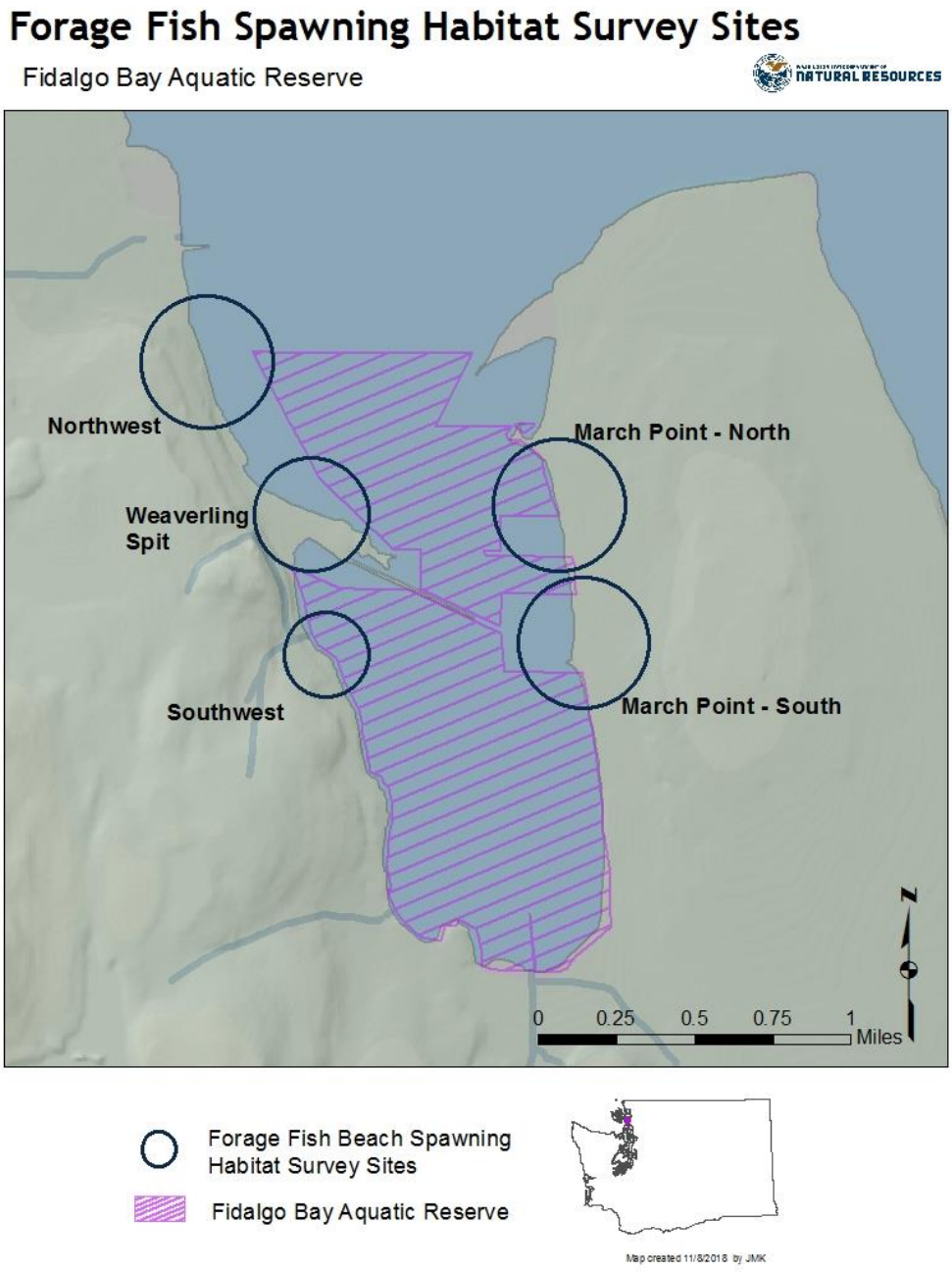

Figure 6: Forage Fish Survey Habitat Sites in Fidalgo Bay Aquatic Reserve

Most of the forage fish survey habitat spawning sites surveyed by MIAR CSC volunteers are associated with shoreline restoration projects. Shoreline restoration projects are being led by King County at Forest Glen, Lost Lake, and Piner Point. Removal of shoreline armoring and restoration on shorelines is being conducted in hopes of protecting and improving the health and ecological function of MIAR into the future. In addition to forage fish beach spawning surveys, the CSC conducts monitoring of beach profiles, terrestrial arthropods, shoreline vegetation, and documentation of beach wrack and logs. Volunteers collected monthly samples for three years prior to the removal of shoreline armoring in the fall of 2018. Volunteers will continue surveying these same sites monthly in 2019 to gather post restoration data now that the shoreline armoring has been removed. At each restoration site, monitoring occurred along three sample reaches or treatments: a restoration reach (targeted for bulkhead removal), a control reach (existing bulkhead throughout survey dates), and a natural reach (no bulkhead).

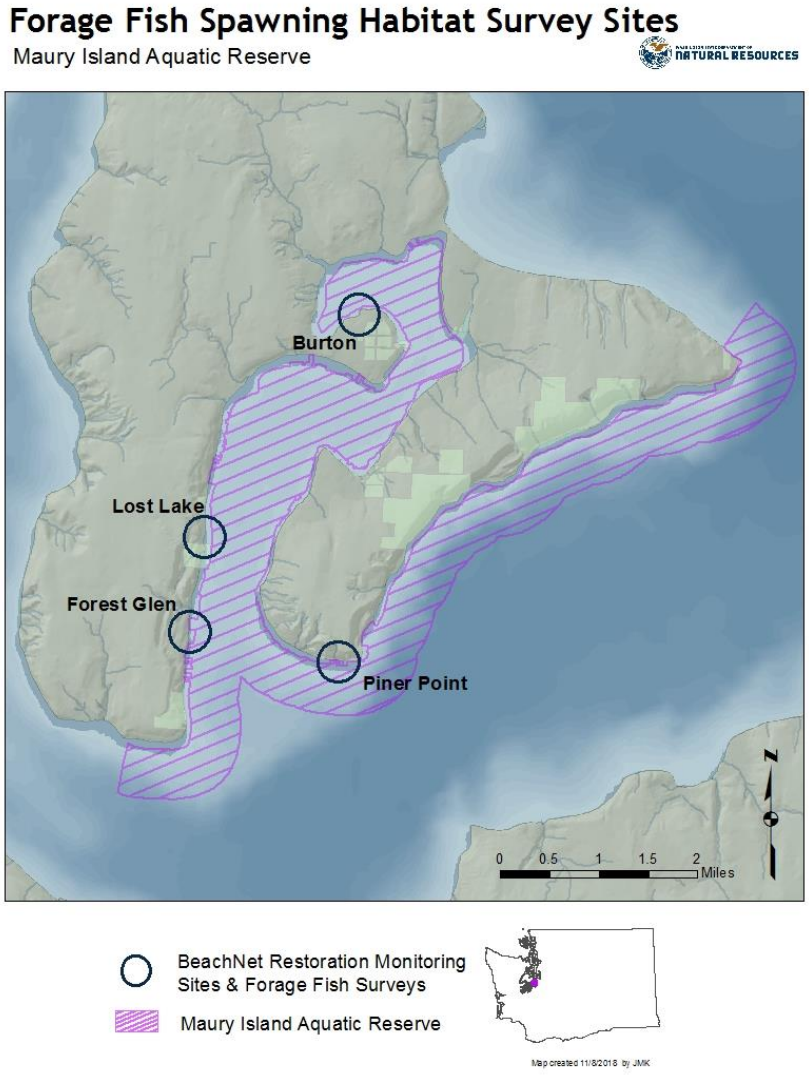

Figure 7: Forage Fish Survey Habitat Sites in Maury Island Aquatic Reserve

The forage fish survey habitat spawning sites surveyed by NRAR CSC volunteers are index sites selected with guidance from WDFW. Volunteers are also seeking out new beaches to sample each season in order to get a better overall view of where forage fish are spawning in the reserve and around south Puget Sound. Surveys were conducted monthly at NRAR and led by scientific technician, Terence Lee. Today, index sites on the mainland include: Tolmie Beach, DeeDee Beach, Luhr Beach, and three sites at DuPont Wharf. Index sites on Anderson Island include: Higgins Cove, Amsterdam Bay, Riviera South.

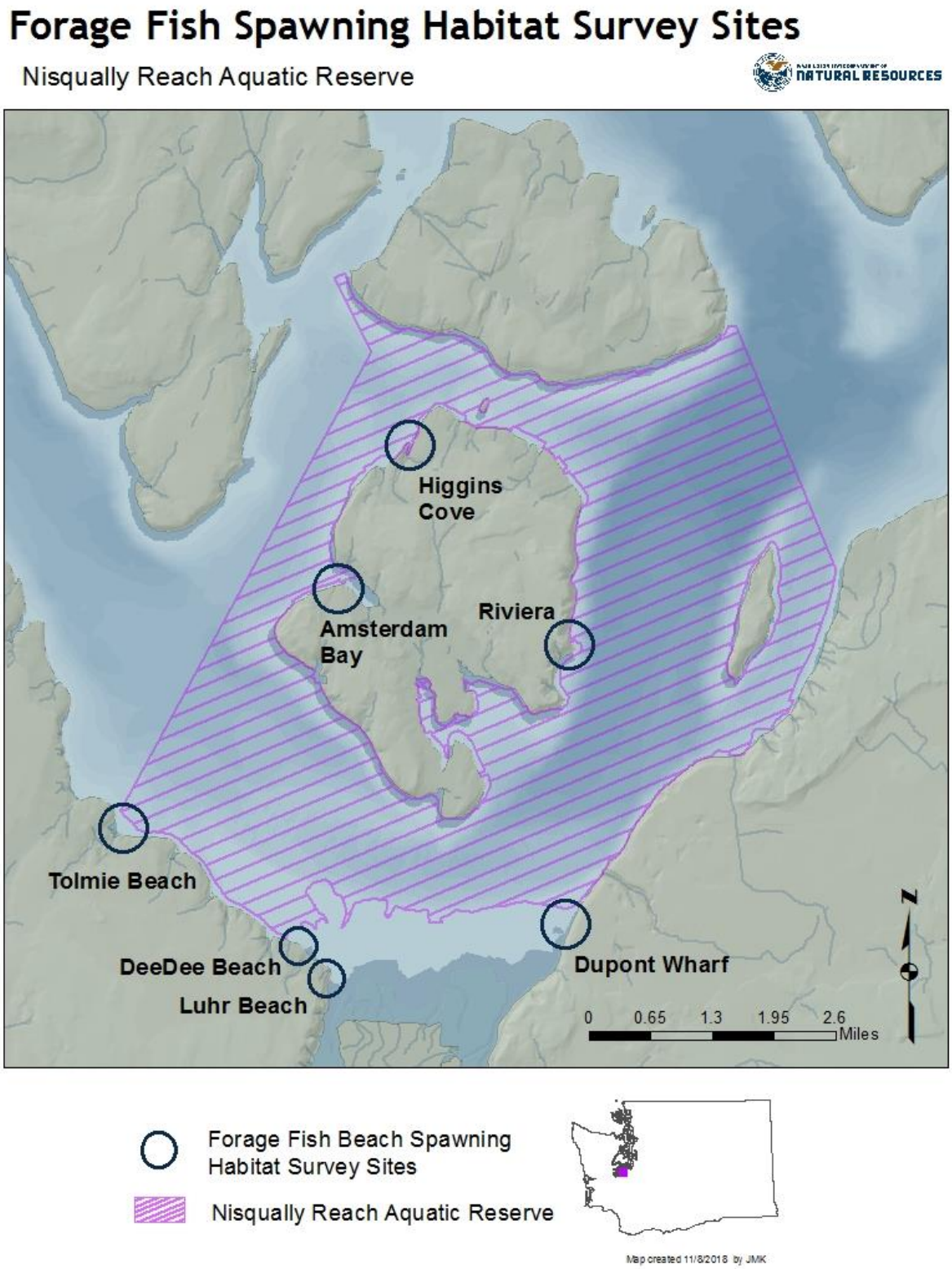

Figure 8: Forage Fish Survey Habitat Sites in Nisqually Reach Aquatic Reserve

Results

These results are a summary of ongoing data collection and are intended to be descriptive. DNR staff and volunteers observe peak forage fish spawning in the south Puget Sound area during the winter months and in northern Puget Sound during the summer. This is consistent with WDFW findings https://wdfw.wa.gov/publications/01219/wdfw01219.pdf (accessed November 15, 2018).

In FBAR, the FBAR CSC observes forage fish spawning year-round, with a peak during the summer months. This also conforms to DNR and WDFW findings. Due to the large number of eggs found in FBAR samples, the results below are presented by percentage of samples with eggs present instead of the number of eggs present.

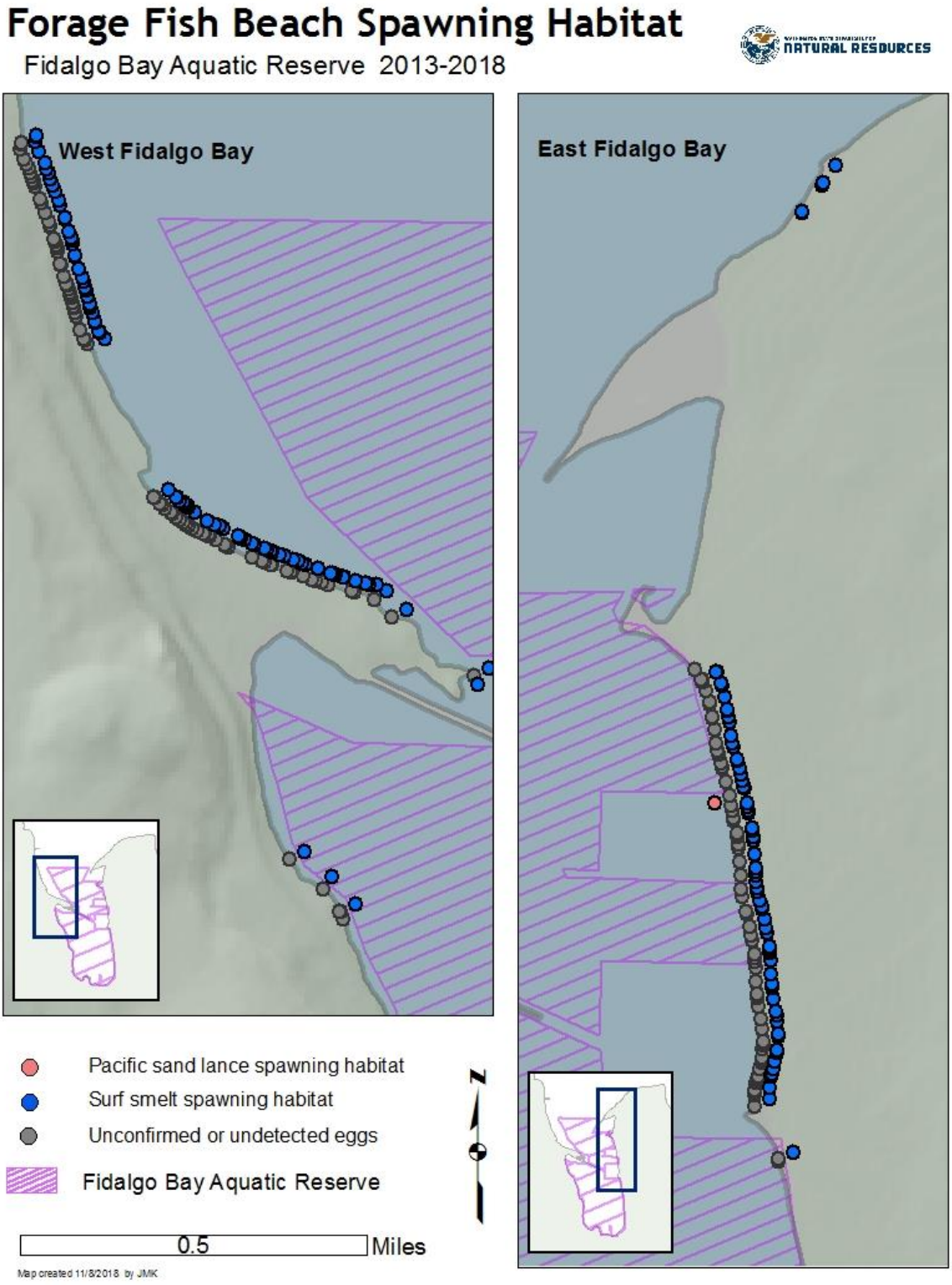

Figure 9: Forage Fish Beach Spawning Habitat in Fidalgo Bay Aquatic Reserve

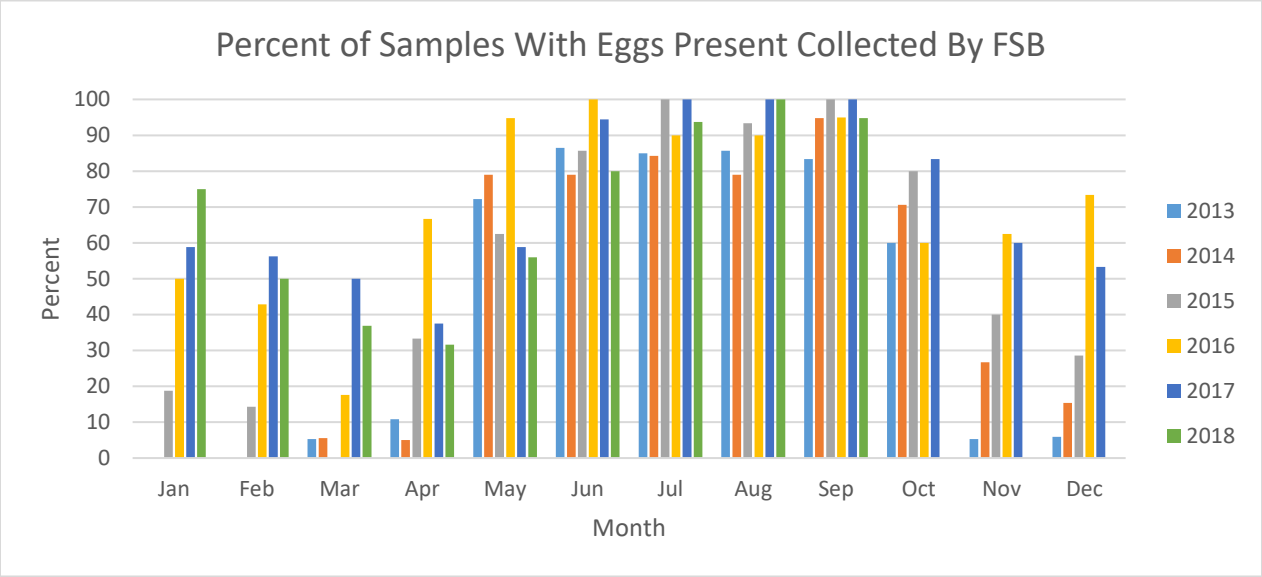

Figure 10: Percentage of Samples with Eggs Present Found in Fidalgo Bay Aquatic Reserve Samples. *Please note, blue bowl analysis of samples began in July, 2015. Also, due to the large number of eggs found in FBAR samples overall, the results are presented here by percentage of samples with eggs present instead of the number of eggs present.

In MIAR, the MIAR CSC's sampling is consistent with what the DNR observes elsewhere in the reserve and in the south Puget Sound. The number of eggs found in the samples collected here peak in October- December and taper off through May, with very little to no spawning observed during the summer months.

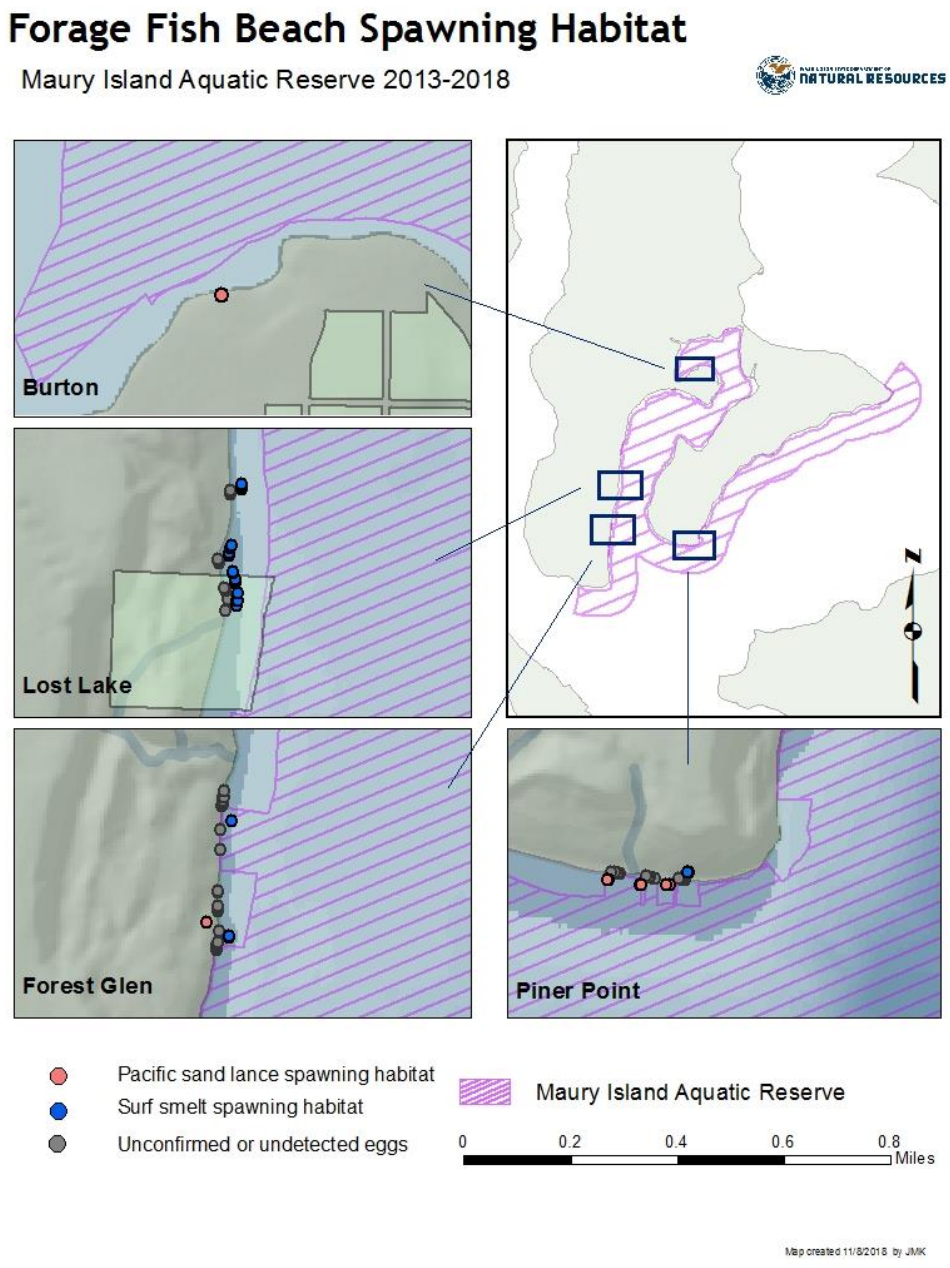

Figure 11: Forage Fish Beach Spawning Habitat in Maury Island Aquatic Reserve

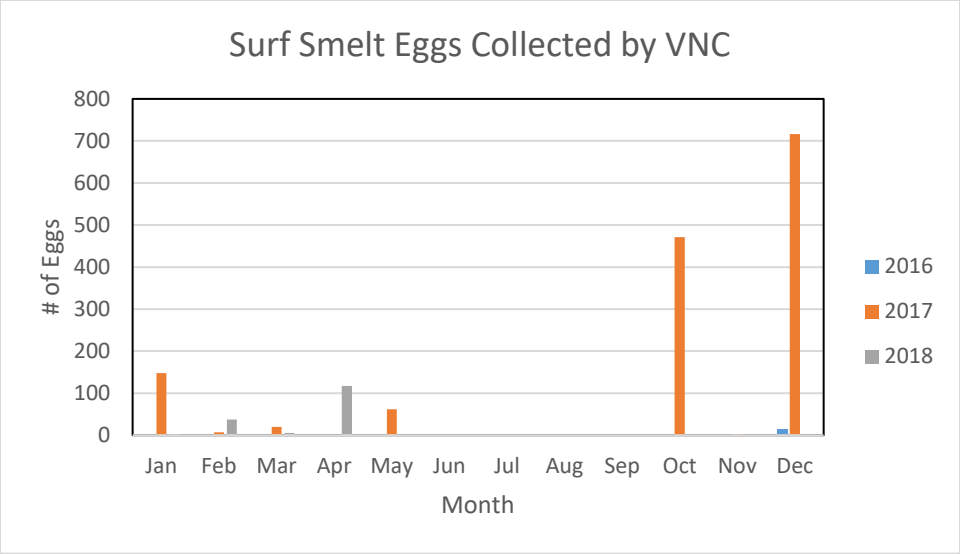

Figure 12: Number of Surf Smelt Eggs Found in Maury Island Aquatic Reserve Samples

In NRAR, NRAR CSC volunteers did not find many forage fish eggs during the first four years of the study. Their findings during the last year are due to adjustment of the locations and beach elevations of where samples are taken and are consistent with the winter spawning patterns observed by DNR staff elsewhere in NRAR. It could also be that the group sampled during a highly productive year, or that they sampled at spawning locations before the tides and currents had much time to distribute the eggs.

The total number of surf smelt eggs found by NRAR CSC was 1,176. With 1,161 of those eggs found near the town of Dupont, this means approximately 98% of surf smelt eggs documented in NRAR by the CSC have been found on Dupont Spit. Volunteers continue to search for new beaches to sample every season.

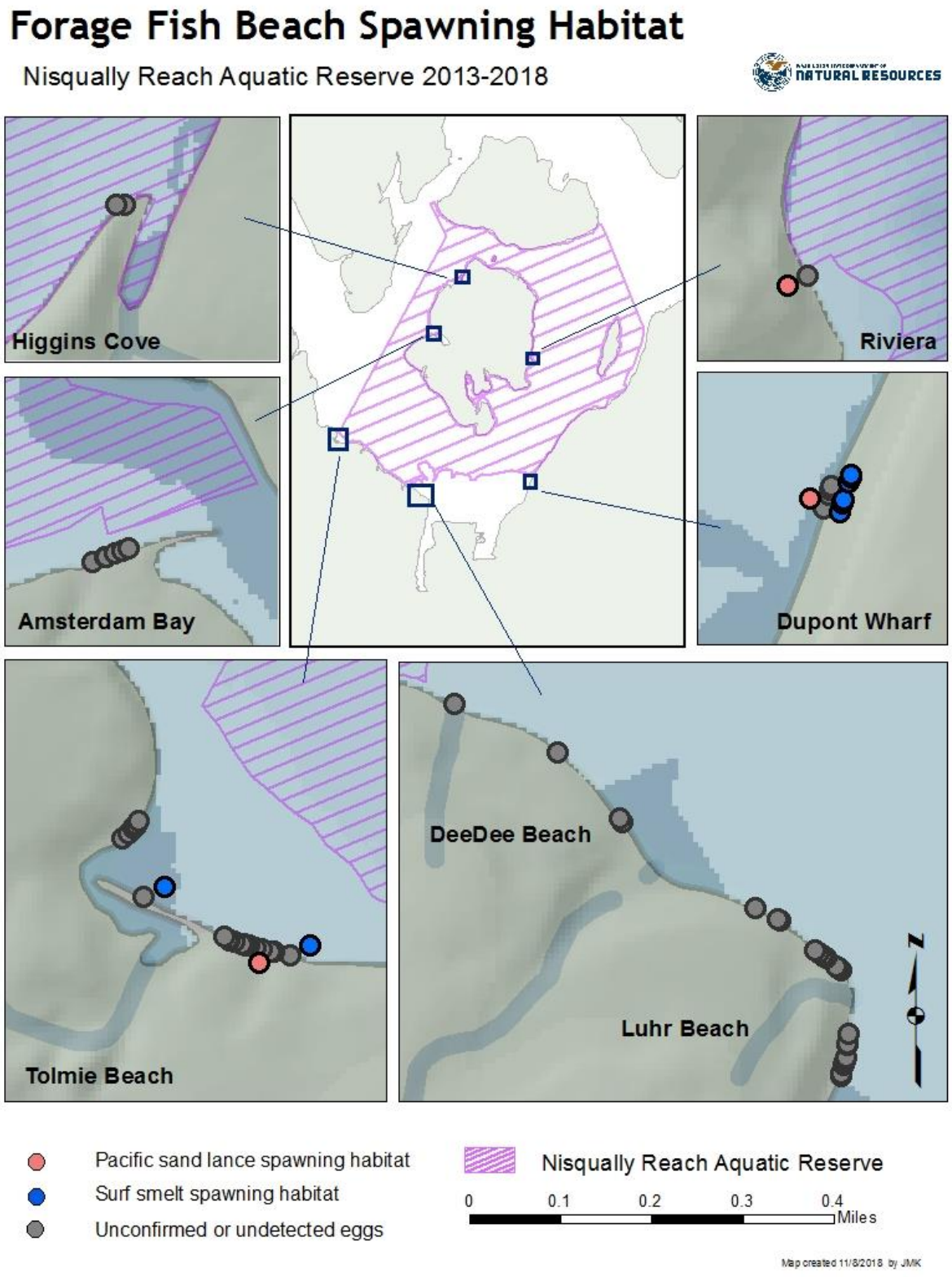

Figure 13: Forage Fish Beach Spawning Habitat in Nisqually Reach Aquatic Reserve

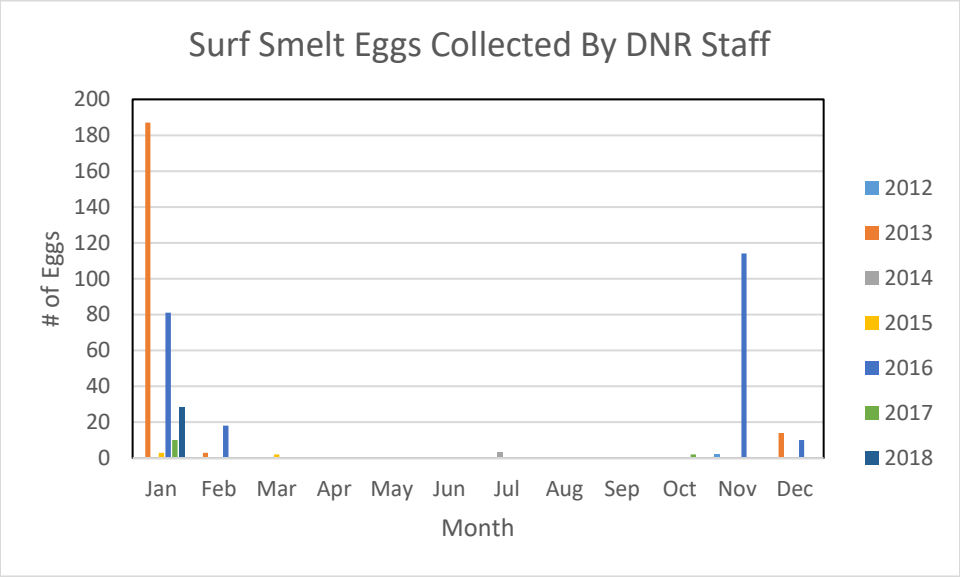

Figure 14: Number of Surf Smelt Eggs Found in Nisqually Reach Aquatic Reserve Samples Collected by DNR Staff

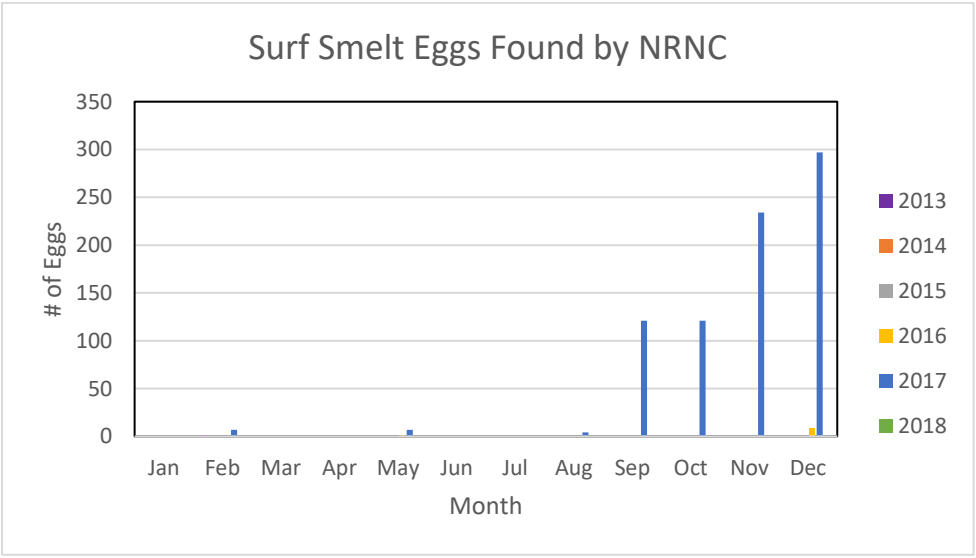

Figure 15: Number of Surf Smelt Eggs Found in Nisqually Reach Aquatic Reserve Samples Collected by NRAR Volunteers

Recommendations and Possible Future Uses of This Data

In FBAR, the FBAR CSC currently conducts forage fish spawning habitat surveys year round, collecting four samples on the east side and six samples on the west side of Fidalgo Bay every month, alternating every week. We recommend reducing sampling by roughly half and only sampling each side once a month. This will reduce workload and free up volunteers for other projects, or allow them the opportunity to dig deeper into forage fish lab work or outreach and education.

Occasional training from Phillip Dionne and WDFW forage fish scientists or the PSC could assist FBAR CSC in gaining competency with forage fish lab work. FBAR CSC's purchase of another dissecting scope will aide in the transition to fully processing their own samples and reduce the need to depend on DNR's help in this area. Another dissecting scope tutorial from the PSC can be arranged in order to facilitate this transition.

In order to continue volunteer engagement and gather worthwhile data, we suggest changing some procedures. One would be targeting sand lance habitat. Sand lance tend to spawn November to January at a lower elevation and in finer sandy sediment. Since we have confirmed sand lance spawning in Fidalgo Bay in the past, it is likely we will find eggs in the future. We recommend focusing on areas where we have identified sand lance in the past, such as the sandy cove at the eastern tip of Weaverling Spit and/or south of Crandall Spit.

Surf smelt spawning habitat distribution has been well established and documented within FBAR. Surveys could therefore be shifted to focus on identifying the boundaries of surf smelt spawning habitat by sampling the edges of areas that are currently being sampled to see if there is a point where eggs are no longer found. This could indicate whether available spawning habitat is shrinking or expanding in Fidalgo Bay.

The results of a monitoring program like this should spur actions that can improve, and better protect, the population of forage fish in the survey area. In FBAR, much of the upper intertidal zone of known spawning habitat lacks shade. Forage fish eggs require upland shading during the hot summer months to protect developing eggs from desiccation (Penttila 2001). It is our recommendation that we work with local and state agencies as well as upland landowners to increase shading by planting native vegetation.

In MIAR, we recommend continuing monthly sampling at all restoration sites and hosting an occasional training led by Phillip Dionne and WDFW forage fish scientists. The purchase of dissecting scopes could aide MIAR CSC in the transition to fully processing their own samples and to depend less on DNR's assistance. A microscope tutorial from the PSC can be arranged in order to facilitate this transition to full sample analysis.

In NRAR, we recommend that NRAR CSC volunteers continue sampling index sites: Tolmie State Park, Hogum Bay, National Fish & Oyster, DuPont Wharf, Riviera South, Higgins Cove,

Amsterdam Bay, and Villa Beach, even as they search for new sites with suitable forage fish habitat. We recommend they continue hosting fall trainings led by Phillip Dionne and WDFW forage fish scientists.

We occasionally find rock sole eggs, which are very similar shape and size to sand lance and surf smelt eggs, while conducting these surveys at the southern reserves. We recommend additional forage fish egg ID training to distinguish surf smelt and sand lance eggs from the superficially similar rock sole eggs that may co-occur in southern Puget Sound samples. In addition, regular QA/QC of analyzed lab samples provide additional reinforcement for continued rigor in the lab, as well as an occasional ID refresher for other commonly confused organisms. Periodic refresher training is recommended.

All CSCs have an on/off switch for the power (connected to an outlet, not a battery) and a valve to shut off the water, which makes vortex sample processing easier than with a battery and pup set-up. Sieving tables could be built in order to further make the sieving process easier as most volunteers sieve their samples on the ground. Elevating the sieve and blue bowl so that volunteers do not have to bend over will save time, energy, and health. The plastic lid for the blue bowl kit can also be replaced with a piece of plywood that fits over the tub. This helps with stability, and allows for fewer gaps into the blue bowl water, which is important to prevent contamination.

Finally, some analysis on live vs. dead eggs has been a feature of forage fish sample lab analysis done with other groups and should be considered in the reserves as well. Comparisons of the percentage of egg mortalities found in sites lacking shade vs. sites with more shading could direct more focused investigations. Factoring in variables such as, the direction and hours of sun exposure on a beach, including installing light sensors and temperature loggers will strengthen this comparison. This data could be used to determine where more shading would be most effective in promoting forage fish egg survival and inform strategic restoration and enhancement efforts.

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Appendix A: Data

Aquatic Reserve	Org	Survey Years	Total # surveys	# Surveys - Eggs Found	# Surveys - Eggs Not Detected
Fidalgo Bay	FB CSC	2013-2018	1131	671	460
Maury Island	MI CSC	2016-2018	144	45	99
Nisqually Reach	NR CSC	2013-2018	95	18	77

Table 3: Surf Smelt Summary

Aquatic Reserve	Org	Survey Years	Total # surveys	# Surveys - Eggs Found	# Surveys - Eggs Not Detected
Fidalgo Bay	FB CSC	2013-2018	1131	2	1129
Maury Island	MI CSC	2016-2018	144	10	134
Nisqually Reach	NR CSC	2013-2018	95	5	90

Table 4: Pacific Sand Lance Summary

Appendix B: Field Forms

Forage Fish Beach Spawning Survey

Page___of___

Month	Day	Year

Last High Tide:	
Time (24hr):	
Elevation:	

Last High Tide:	
Time (24hr):	
Elevation:	

Reserve:

Beach Station #	Sample #	Time (24 hr)	Latitude (decimal degrees)	Longitude (decimal degrees)	Beach	Uplands	Width	Length	Landmark	Sample Zone	Tidal Elevation	Shading	Smelt	Sand lance	Rock sole	Comments	Photo #

Samplers (First Initial. Last):_____

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Figure 16: Forage Fish Beach Spawning Survey Field Form

Appendix C: Protocol

The sampling design follows the WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols, Procedures for Obtaining Bulk Beach Substrate Samples (Moulton and Penttila, 2001).

The sampling protocol is as follows:

Note: Sampling should occur on the lowest tide practicable. Prior to sampling any site, consult tide tables to ensure you will be able to access the +7-9 (surf smelt) and +5-8 (sand lance) tidal height. It may also be necessary to obtain permission to access the beach from private or corporate landowners.

Procedure:

1. Upon arriving on the beach, fill out the header information on the attached data sheet. Do not fill in "Reviewed by." Before conducting the first sample, describe the character of the upland and beach environment using the codes provided on the back of the data sheet. For additional details on sample codes, (Moulton and Penttila, 2001).

2. Identify a landmark from which you will measure the distance to the bulk substrate sample tidal elevation. Typical landmarks include the upland toe of the beach, the last high tide mark or wrack line, and the edge of the water.

3. Measure the distance from the landmark to the tidal elevation to be surveyed.

4. Stretch a measuring tape at least 100 feet along the selected tidal height. Note that beach contours may cause the landmark to be "wavy" and that the tape should remain a consistent distance from the landmark.

5. Standing at the 50-foot mark of the measuring tape, record a GPS fix on the data sheet.

6. Using a 16-ounce sample jar or large scoop remove the top 5-10 cm (2-4 in) of sediment from the location recorded in Step 5 above. Place the sediment in an 8 inch x 24 inch polyethylene bag. You may need to take two scoops to get sufficient sediment, depending on the coarseness of the beach.

7. Walk 33 feet along the measuring tape, repeat the sediment scooping action, and place the sediment in the bag. Move an additional ten paces and repeat. Move an additional ten paces, approximately to the end of the tape, and repeat. The bag should now have sediment from four locations along the tape and be at least ½ to ⅔ full. Place completed waterproof sample label in bag with sediment. Label should include reserve name, Beach# sample#, data and sampler initials.

8. If additional transects, representing various tidal heights, along the beach are to be surveyed, place the sample bag in a cool, shady place and repeat the above procedures at these additional locations. If no additional samples will be taken, move on to wet sieving and winnowing.

9. Wash sediment through a stack of sieves, 4mm, 2mm, and 0.5mm in mesh size. Transfer the sediment that is left over in the smallest sieve into the blue bowl setup. While the water is running, agitate sediment for two minutes, and then turn off the water. The finest sediment and eggs should have ended up on the small sieve under the blue bowl.

10. Transfer the winnowed subsample in a sample jar, making sure threads are clean to ensure a tight seal. Label each jar (in pencil) with reserve name, date, and beach# sample#. If samples may not be transported within 24hours, the preservative Stockard's Solution may be added. If it is added, the closed jar should be inverted at least three times to be sure all the preservative is distributed. When using Stockard's Solution, mark the jar with a large X to indicate a preservative has been used. See Figure 11 as an example of labeling.

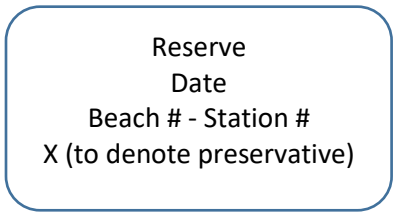

Figure 17: Example of Labeling a Sample Jar

11. Store sample collections in a cool location, making sure the samples are not frozen. Transport samples to WDFW personnel for analysis within 24 hours of collection unless a preservative has been used.

12. Take six photos standing at the center of the site, and recorded the file number of the first photo in the series. Photo 1: close up of the completed sample tag. Photo 2: Place sample tag on the ground, take photo of sediment and sample tag with scale bar taken from waist level. Photo 3: Beach backshore. Photo 4: Turn 90 degrees clockwise to take a picture of the right beach. Photo 5: turn 90 degrees clockwise to take a picture of the beach foreshore (towards the water). Photo 6: turn 90 degrees clockwise to take a picture of the left beach.